Harold E. Saunders
Maneuvering and Seakeeping (MASK) Facility
New Directional Wavemaker
Maneuvering And Seakeeping Basin
MASK
Maneuvering And Seakeeping Basin

MASK

98.3 m
322.5 ft
Maneuvering And Seakeeping Basin

MASK

61.7 m
202.5 ft

6.1 m
20.0 ft
Maneuvering And Seakeeping Basin

MASK

New Directional Wavemaker
Acknowledgements

- Wavemaker Replacement Advocates
  - Maritime Technology Alliance
  - Commanders and Technical Directors
  - Naval Architecture and Engineering Department

- Government Wavemaker Team
  - Facilities Division
  - Seakeeping Division
  - Contracting Officials and Financial Managers

- Contractor Wavemaker Team
  - MAR (Prime Contractor – Coordination, Engineering Leadership)
  - Edinburgh Designs Limited (Wavemaker Designer)
  - Atlantic Industrial Technologies (Machinery Fabrication and Engineering Design)
  - INCON (Installation of Machine and Structural and Electrical Support Components)
  - McLaren Associates (Design and Inspection of Concrete Support Structure)

Wavemaker was a long process with many contributors!!!
General Agenda

• History of Wavemakers at Naval Surface Warfare Center, Carderock Division (NSWCCD)

• Need For Replacement

• EDL Design

• Design, Demolition and Installation

• Wavemaker performance and wave environment modeling

• Commissioning and characterization

• Future work and benefit to NAVY and Marine Industry

• Benefits of new wavemakers
Adm. David W. Taylor

Rear Admiral David Watson Taylor, USN Retired (1864 - July 1940) was a naval architect and engineer of the United States Navy. He graduated with the highest grade average in U.S. Naval Academy history. He served during World War I as Chief Constructor of the Navy, and Chief of the Bureau of Construction and Repair. Taylor is best known as the man who constructed the first experimental towing tank ever built in the United States. The Navy's Research and Development community honored Taylor by naming its new model basin, constructed at Carderock, Maryland, after him. The Model Basin retains his name as a living memorial to this distinguished naval architect and marine engineer.
Capt. Harold E. Saunders

Captain Harold Eugene Saunders, USN Retired (1890–1961) was a distinguished career Naval officer. He graduated with the second highest grade average in U.S. Naval Academy history, second to David W. Taylor. He served at the Portsmouth, New Hampshire Navy yard and was involved in the design and construction of submarines. He received the Navy Distinguished Service Medal for his work in salvaging the USS S-4 (SS-109) in 1927. Saunders was a member of the first and second Byrd expeditions to Antarctica, where he served as a geographer. The Saunders Ice Shelf, Saunders Coast, and Saunders Mountain are named for him. He is best known for being the Chief Constructor of the David Taylor Model Basin. He authored the 3-volume book, Hydrodynamics in Ship Design, which was published in 1957 by SNAME. The Maneuvering And Seakeeping Basin retains his name as a living memorial to this distinguished naval architect and marine engineer.
History of NSWCCD Wavemakers

- Experimental Model Basin at Navy Yard actually had a wavemaker in 1920’s.
History of NSWCCD Wavemakers Cont’d

• Plans for Maneuvering and Seakeeping Facility (MASK) developed in 1950’s
History of NSWCCD Wavemakers Cont’d

- Original Towing Basin did not include wavemakers
- Some pneumatic concepts tested at smaller scales, in anticipation of adding that capability to the large towing basins
The early 1950’s saw the installation of wavemakers in the towing basins.
• Plans for Maneuvering and Seakeeping Facility (MASK) included a model tank to evaluate the new design before manufacture.

Figure 2 Long-crested sinusoidal waves covering the entire range of wave lengths and assorted wave heights.
History of NSWCCD Wavemakers

• Pneumatic wavemaker chosen due to lower maintenance
• Original design called for single shaft both banks
  – Single long shaft on long bank allowed skewing
• Refurbishment of domes and valves performed in mid 1980’s
Wavemaker Replacement Process

- **EG&G Independent Analysis (June 2005 to August 2006)**
  - Review of cost and technologies
  - Required to provide background information for Congressional funding

- **White Paper – NAVY’s need for new wavemaker (Dec/Jan 2006)**
  - Frequency response
  - Ability to produce lower sea state for littoral efforts
  - Ability to produce non-orthogonal bidirectional seaway

- Seaport Contract to support multi-year funding (2007)
- Contract Award September 2007
- Majority of funding was provided via congressional plus ups
- Final funding provided via NAVSEA
Replacement Wavemaker
General Theory

- 2.5 m (8.2 ft.) hinge depth
- 0.658m (25.9 in.) pitch (centerline to centerline spacing)
- Dry back wavemaker
- Paddle driven with timing belt on sector
- Motor and pulley box mounted above
- Hydrostatic compensation with air tank and bellows
- Force feedback (absorption) control
Replacement Wavemaker General Theory Cont’d

- Pulley Box Drive Arrangement
Replacement Wavemaker
General Theory

• Bellows and Lower Force Transducer Arrangement
Design Cycle, Fabrication and Quality Control

- Contracting Team provided preliminary design via proposal
- Contracting and Government teamed to discuss more specifics
  - Contractor and Government Design Team observed previous EDL design
  - Contractor Team worked through greater details to create final design
- Government and Contracting Team reviewed design
  - Team worked together to review design and approve parts for fabrication
  - Drawings and concepts were corrected and altered as required
  - Long lead items were procured
- **Contractor performed quality control check throughout fabrication**
  - Paddle impact test
  - Tank and bellows testing
  - Measurement jigs
  - Multi paddle mockup at AIT
  - Gusset fitment
  - Cabinet burn in with motors
Demolition and Installation

- **Pre-Install Activities**
  - Determination and routing of 13.8KVa feeds and step down supplied power
  - Laydown areas and safety

- **Draining of Water and Demolition**
  - Draining basin, pressure equalization, dewatering
  - Removal of 21 pneumatic domes and other associated wavemaker components

- **Installation Support Structure**
  - Concrete shelves, hinge mounts, motor frames (with motor pulley boxes)

- **Installation Major Mechanical and Electrical Components**
  - Tank and bellows, paddles and sectors, gussets, electrical distribution and control cabinets

- **Maintenance and Safety Components**
  - Caisson rail and pocket, catwalks, railings

- **Leak mitigation and final adjustments**
Wavemaker Environment Modeling

- Regular wave production
- Irregular wave production
- Directional wave production
- Short crested vs. long crested seaway (spreading)
- Deterministic wave events
- Focused wave events

Wavemaker Capabilities Video
Wavemaker Environment Modeling

- Preprogrammed Spectral Shapes
  - Bretschneider, Pierson-Moskowitz, ITTC, JONSWAP (Hs, Tp, and gamma as appropriate)
  - Can Specify and Vary – Spectral Heading, Spreading, and Random Phasing

- Customizable spectral shape and wave front definition
  - Other Spectral Shapes Can Be Specified via Coordinates
  - Wavemaker can also be programmed via wave fronts (Spectral ordinate, frequency, phase)

Wavemaker Visualization Software of Spread Spectra and Long Crested Spectra at 70 Degree Separation

Spread Spectra and Long Crested Spectra at 70 Degree Separation
Correcting MASK Spectra For Wave Breaking

- When testing in higher sea-states breaking can be prevalent
- Breaking limits ability to achieve the desired wave conditions
- NSWCCD developed methodology to correct the target reducing the breaking while maintaining Hs and Tp
- Allows meaningful testing in steep storm-type sea-states
Commissioning and Characterization

- Wavemaker commissioning
  - Individual component checks
  - Bringing full system up to full operation
  - Tuning of all components
  - Verification that machine meets performance specification
  - Acceptance of wavemaker delivery

- Wavemaker characterization
  - How does the machine operate within the seakeeping basin
  - What are specifics of how to use the machine in the seakeeping basin
  - How can the facility best use the new machine to meet testing needs
  - Characterization will be a continuing process …..

- Some commissioning and characterization overlap
Future Work and Benefits

• Non-orthogonal bi-directional seaways
• Short crested seaways
• Better machine control
  – Greater capability and control at high frequencies
  – High performance craft scaling flexibility
  – Deterministic seaway testing
  – Wave energy conversion testing
• Multi-vessel testing
• Littoral capabilities
New Wavemakers In Towing Basin

- Design to be on movable shelf
- Can move down to operate basin in shallow water mode
- Possible surf testing in high speed basin
- Ability to absorb some wake for calm water testing?
- Ability to time frequencies for shorter wait times?
Questions

For more information regarding capabilities, scheduling, and availability, please contact:

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